

What is claimed is:

1. In a vehicle having occupant protection means for protecting an occupant of said vehicle and a microprocessor for controlling said occupant
5 protection means, the improvement comprising:

a vehicle seat comprising sensing means for providing data for
ascertaining the position of an occupant of said seat with respect to a reference frame
fixed with respect to the structure of said vehicle,
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a calculator adapted to calculate said position of said occupant of said
seat from input comprising said data, and

means for transmitting said position of said occupant of said seat to
15 said microprocessor.

2. The invention as defined by Claim 1 wherein said seat comprises a
seat back and a seat cushion, and said sensing means comprises:

20 one or more sensors for providing data for ascertaining the position
of said seat back and said seat cushion with respect to said reference frame, and

one or more sensors for providing data for ascertaining the position
of said occupant of said seat with respect to said seat back and said seat cushion.
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3. The invention as defined by Claim 2 wherein:

said seat is movable on a seat track, and

30 one of said sensors for providing data for ascertaining the position of
said seat back and said seat cushion with respect to said reference frame comprises

a position sensor for indicating the position of said seat on said seat
track.

4. The invention as defined by Claim 2 wherein

one of said sensors for providing data for ascertaining the position of
said seat back and said seat cushion with respect to said reference frame comprises

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a sensor for indicating the recline angle of said seat back.

5. The invention as defined by Claim 2 wherein said one or more
sensors for providing data for ascertaining the position of said seat occupant with
10 respect to said seat back and said seat cushion comprises:

a first capacitor electrode, a second capacitor electrode, and

a sensor responsive to the capacitance between said first capacitor
15 electrode and said second capacitor electrode.

6. The invention as defined by Claim 2 wherein said one or more
sensors for providing data for ascertaining the position of said seat occupant with
respect to said seat back and said seat cushion comprises:

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a first capacitor electrode and a second capacitor electrode
electrically insulated from each other,

means for applying an alternating electric voltage between said first
25 capacitor electrode and said second capacitor electrode, and

a sensor responsive to displacement current between said first
capacitor electrode and said second capacitor electrode.

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7. The invention as defined by Claim 6 wherein

said sensor responsive to displacement current comprises:

a resistor connected so that said displacement current passes through
35 said resistor, and

voltage sensing means responsive to voltage across said resistor.

8. The invention as defined by Claim 2 wherein

said sensors for providing data for ascertaining the position of said occupant of said seat with respect to said seat back and said seat cushion comprises

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a first sensor for providing first data for ascertaining a first distance between a first location on the back of said occupant of said seat and a second location on said seat back.

- 10 9. The invention as defined by Claim 8 wherein said first sensor for providing first data for ascertaining a first distance comprises:

a first seat back capacitor electrode in said seat back,

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a first seat cushion capacitor electrode in said seat cushion, and

a sensor responsive to capacitance between said first seat back capacitor electrode and said first seat cushion capacitor electrode.

- 20 10. The invention as defined by Claim 8 wherein:

said sensors for providing data for ascertaining the position of said occupant of said seat with respect to said seat back and said seat cushion comprises

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a second sensor for providing second data for ascertaining a second distance between a third location on the back of said occupant of said seat and a fourth location on said seat back comprising:

a second seat back capacitor electrode in said seat back, and

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a sensor responsive to capacitance between said second seat back capacitor electrode and said first seat cushion capacitor electrode in said seat cushion.

11. The invention as defined by Claim 10 wherein:

said calculator is adapted to calculate said first distance from said first data, said first distance defining a first point forward of said seat back,

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said calculator is adapted to calculate said second distance from said second data, said second distance defining a second point forward of said seat back,

said calculator uses said two points to define in said reference frame
10 fixed with respect to the structure of said vehicle a plane surface having said first point and second point thereon, and also having thereon a horizontal line extending transverse to the direction of forward movement of said vehicle, and

said position of said occupant of said seat calculated by said
15 calculator is the position of a human having thighs adjacent said seat cushion and a back adjacent said plane surface.

12. The invention as defined by Claim 11, and including

20 a weight sensor responsive to the weight of said seat occupant, and wherein

said calculator is adapted to assume said occupant of said seat is a human having average dimensions of humans having the weight estimated by said
25 weight sensor when human dimensions are relevant to its calculations.

13. The invention as defined by Claim 8 wherein

said first sensor comprises:

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a first emitter for generating a first sound, a first receiver for receiving an echo of said first sound, and a timer for measuring the time between when said first sound is generated and the time when said echo of said first sound is received.

14. The invention as defined by Claim 8 wherein

said sensors for providing data for ascertaining the position of said occupant of said seat with respect to said seat back and said seat cushion comprises

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a second sensor for providing second data for ascertaining said first distance, whereby

data are provided for making two independent ascertainments of said first distance between a location on the back of said seat occupant and a location on said seat back.

15. The invention as defined by Claim 14 wherein said second sensor for providing second data comprises:

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a second emitter for generating a second sound, a second receiver for receiving an echo of said second sound, and a timer for measuring the time between when said second sound is generated and the time when said echo of said second sound is received.

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16. The invention as defined by Claim 14 wherein:

said calculator is adapted to calculate a first occupant position from said first data,

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said calculator is also adapted to calculate a second occupant position from said second data, and

said calculator is adapted to use said first and second occupant positions when calculating said position of said occupant of said seat with respect to a reference frame.

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17. The invention as defined by Claim 14 wherein:

said first data for ascertaining said first distance is used for said
ascertaining the position of said seat occupant with respect to said seat back and said
5 seat cushion when said first distance is less than a predetermined distance, and

said second data for ascertaining said first distance is used for said
ascertaining the position of said seat occupant with respect to said seat back and said
seat cushion when said first distance is greater than said predetermined distance.

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18. The invention as defined by Claim 1, and including

an accelerometer responsive to decelerations resulting from a crash,
and wherein:

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said calculator is adapted to receive values of said decelerations from
said accelerometer and is also adapted for computing values of the second integral of
said deceleration as said crash progresses, and

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said calculator is adapted to use said values of said second integral
when calculating said position of an occupant of said seat with respect to a reference
frame fixed with respect to the structure of said vehicle.

19. The invention as defined by Claim 18, and wherein:

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said calculator comprises means for calculating the velocity of said
occupant of said seat with respect to a reference frame fixed with respect to the
structure of said vehicle from input comprising said data, and

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said calculator is adapted to use said velocity when calculating said
position of an occupant of said seat with respect to a reference frame fixed with
respect to the structure of said vehicle.

20. The invention as defined by Claim 18, and including

a seat belt for restraining an occupant of said seat, and wherein:

5 said seat belt comprises a latch,

said latch is adapted to provide a seat belt latched signal indicating if
said seat belt latch is or is not latched, and

10 said calculator is adapted to said use said values of said second
integral only when said seat belt latched signal indicates said seat belt is not latched.

21. The invention as defined by Claim 8, and including

15 an accelerometer responsive to decelerations resulting from a crash,
and wherein:

said calculator is connected for receiving values of said deceleration
from said accelerometer and is adapted for computing values of the second integral
20 of said deceleration as said crash progresses, and

said calculator is adapted to use said values of said second integral
when calculating said position of an occupant of said seat with respect to a reference
frame fixed with respect to the structure of said vehicle.

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22. The invention as defined by Claim 18, and wherein:

said calculator comprises means for calculating the velocity of said
occupant of said seat with respect to a reference frame fixed with respect to the
30 structure of said vehicle, and

said calculator is adapted to transmit said velocity to said
microprocessor.

23. The invention as defined by Claim 8, wherein

said sensors for providing data for ascertaining the position of said seat occupant with respect to said seat back and said seat cushion comprises

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a sensor for providing second data for ascertaining a second distance between the back of said seat occupant and said seat back, and wherein:

said calculator is adapted to ascertain said first distance from said first data and said second distance from said second data,

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said calculator is adapted to use said first distance and said second distance to define two points in a reference frame fixed with respect to the structure of said vehicle,

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said two points define a plane surface containing said two points and a horizontal line extending transverse to the direction of forward movement of said vehicle, and

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said calculator calculates said position of an occupant of said seat with respect to a reference frame fixed with respect to the structure of said vehicle to be the position of a human having thighs adjacent said seat cushion and a back adjacent said plane surface.

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24. In a vehicle having occupant protection means for protecting an occupant of said vehicle and a microprocessor for controlling said occupant protection means, the improvement comprising:

a vehicle seat comprising a seat back, a seat cushion, and an occupant sensor responsive to distance from a location on said seat to a location on said occupant by producing a first signal categorizing an occupant of said seat into one of at least three categories, and wherein

said microprocessor is responsive to said first signal when controlling said occupant protection means.

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25. The invention as defined by Claim 24 wherein said occupant sensor comprises:

a first capacitor electrode, a second capacitor electrode, and

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a sensor responsive to the capacitance between said first capacitor electrode and said second capacitor electrode.

26. The invention as defined by Claim 24 wherein said occupant sensor
10 comprises:

a first capacitor electrode and a second capacitor electrode electrically insulated from each other,

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means for applying an alternating electric voltage between said first capacitor electrode and said second capacitor electrode, and

a sensor responsive to displacement current between said first capacitor electrode and said second capacitor electrode.

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27. The invention as defined by Claim 26 wherein said sensor responsive to displacement current is responsive to both the magnitude and phase of said displacement current, whereby

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said occupant sensor is responsive to both the magnitude and Q of capacitance between said capacitor electrodes.

28. The invention as defined by Claim 26 wherein said sensor responsive to displacement current comprises:

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a resistor connected so that said displacement current passes through said resistor, and

voltage sensing means responsive to voltage across said resistor.

29. The invention as defined by Claim 24 including:

a second occupant sensor responsive to distance from a second location on said seat to a second location on an occupant by producing a second
5 signal, and wherein

said microprocessor is responsive to said first signal and said second signal when controlling said occupant protection means.

10 30. The invention as defined by Claim 24 wherein

said categorizing an occupant of said seat into one of at least three categories is into categories of occupant position.

15 31. In a vehicle having occupant protection means for protecting an occupant of said vehicle and decision making means for controlling said occupant protection means, the improvement comprising:

a vehicle seat comprising capacitor electrodes,
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seat occupant categorizing means responsive to capacitance between said capacitor electrodes by categorizing an occupant of said seat into one of at least three categories, and

25 means for transmitting said category to said decision making means.

32. The invention as defined by Claim 31 wherein said seat occupant categorizing means is responsive to both the magnitude and Q of said capacitance between said capacitor electrodes.

33. The invention as defined by Claim 31 wherein said seat comprises a seat back and a seat cushion, and

said capacitor electrodes comprise a seat back capacitor electrode in
5 said seat back and a seat cushion capacitor electrode in said seat cushion.

34. The invention as defined by Claim 31 wherein said seat occupant categorizing means causes displacement current to flow between said capacitor electrodes, and
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said seat occupant categorizing means is responsive to said displacement current by said categorizing said occupant of said seat into one of at least three categories.

15 35. The invention as defined by Claim 34 wherein said seat occupant categorizing means is responsive to both the magnitude and phase of said displacement current, whereby

said seat occupant categorizing means is responsive to both the
20 magnitude and Q of said capacitance between said capacitor electrodes.

36. The invention as defined by Claim 34 wherein:

said seat comprises a first capacitor electrode and a second capacitor
25 electrode, and

said seat occupant categorizing means causes said displacement current by applying an alternating electric voltage between said first capacitor electrode and said second capacitor electrode.

37. The invention as defined by Claim 34 wherein

said seat occupant categorizing means comprises:

5 a resistor connected so that said displacement current passes through said resistor, and

said occupant categorizing means is responsive to said displacement current by responding to voltage across said resistor by said categorizing said
10 occupant of said seat into one of at least three categories.

38. In a vehicle having occupant protection means for protecting an occupant of said vehicle and decision making means for controlling said occupant protection means, the improvement comprising:

15 a vehicle seat comprising capacitor electrodes,

means for causing displacement current to flow between said capacitor electrodes,

20 means responsive to said displacement current by categorizing an occupant of said seat into one of at least three categories, and

means for transmitting said category to said decision making means.
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39. The invention as defined by Claim 38 wherein said seat occupant categorizing means is responsive to both the magnitude and phase of said displacement current, whereby

30 said occupant categorizing means is responsive to both the magnitude and Q of said capacitance between said capacitor electrodes.

40. The invention as defined by Claim 38 wherein:

said seat comprises a first capacitor electrode and a second capacitor electrode, and

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said means for causing displacement current comprises means for applying an alternating electric voltage between said first capacitor electrode and said second capacitor electrode.

10 41. The invention as defined by Claim 38 wherein said seat comprises a seat back and a seat cushion, and

said capacitor electrodes comprise a seat back capacitor electrode in said seat back and a seat cushion capacitor electrode in said seat cushion.

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42. The invention as defined by Claim 38 wherein a said capacitor electrode comprises fabric which has been adapted to be electrically conductive.

43. The invention as defined by Claim 38 wherein

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said seat occupant categorizing means comprises:

a resistor connected so that said displacement current passes through said resistor, and

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said means responsive to said displacement current is responsive to voltage across said resistor by said categorizing an occupant of said seat into one of at least three categories.

30 44. The invention as defined by Claim 38 wherein

said categorizing an occupant of said seat into one of at least three categories is into categories of occupant position.